DRIP IRRIGATION HOSE WITH ROOT DETERRENT STRIP

BACKGROUND OF THE INVENTION

Drip irrigation systems have come into widespread use in the agricultural area. Drip irrigation systems supply water at a slow, controlled rate to the root zone of the particular plants being irrigated. Typically, drip irrigation is accomplished by providing a low volume water outlet at each plant that permits a limited dripping of water directly to the root zone of the particular plant. These hoses are usually installed slightly underground to protect them from wind, rodents, sun and machinery and to aid the flow of the water into the soil.

One of the problems with such a drip irrigation installation is that, if the farmer does not irrigate enough to satisfy the needs of the plants, roots will grow to find more water. As the hose usually has some residual water left in it, the roots will seek the water, entering the water outlet and eventually plugging it. When this process starts, uniformity of water distribution becomes erratic, and shortly unsatisfactory crop response results.

SUMMARY OF THE INVENTION

The present invention provides a novel solution to root ingrowth. In one embodiment, the invention is directed to a drip irrigation hose having an interior surface, an exterior surface and a water supply passage extending therethrough. One or more outlets are provided that connect the water supply passage to the exterior of the hose. One or more root deterrent strips are attached to the interior surface or the exterior surface of the hose at or near the outlets. Each root deterrent strip comprises a fabric strip impregnated with a chemical herbicide.

In a particularly preferred embodiment, the invention is directed to a drip irrigation hose having an interior surface, an exterior surface, a water supply passage and a plurality of flow regulating channels that are smaller than the water supply passage. The flow regulating channels each comprise an inlet section comprising one or more openings connecting the water supply passage to that flow regulating channel, and an outlet section comprising one or more openings connecting that flow regulating channel to the exterior of the hose. The hose further comprises one or more root deterrent strips as described above attached to the interior surface or the exterior surface of the hose at or near the openings of the inlet section or the outlet section.

DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will be better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a cross-sectional view of a drip irrigation hose having a flow regulating channel between its margins.

FIG. 2 is a top sectional view of a flow regulating channel according to the invention.

FIG. 3 is a schematic block diagram of the method for making a drip irrigation hose of the continuous emitter type.

FIG. 4 is a schematic view of a portion of the film path for making a drip irrigation hose in accordance with the invention.

FIG. 5A is a side partial cutaway view of an irrigation hose according to the invention having a longitudinal root deterrent strip attached to the exterior of the hose over the outlets.

FIG. 5B is a side partial cutaway view of an irrigation hose according to the invention having a root deterrent strip wrapped around the exterior of the hose over the outlets.

FIG. 5C is a side partial cutaway view of an irrigation hose according to the invention having a longitudinal root deterrent strip attached to the interior of the hose over the outlets.

FIG. 5D is a side partial cutaway view of an irrigation hose according to the invention having a root deterrent strip wrapped around the interior of the hose over the outlets.

FIG. 5E is a side partial cutaway view of an irrigation hose according to the invention having a longitudinal root deterrent strip attached to the exterior of the hose near the outlets.

FIG. 5F is a side partial cutaway view of an irrigation hose according to the invention having a root deterrent strip wrapped around the exterior of the hose near the outlets.

DETAILED DESCRIPTION

The present invention employs a root deterrent strip attached to the interior or exterior of the hose to discourage root intrusion. The root deterrent strip comprises a fabric strip impregnated with a chemical herbicide. The invention provides a mechanism for keeping the herbicide in close proximity to the outlet(s) of the hose without blocking water flow.

As shown in FIGs. 1, 2 and 5, a flexible drip irrigation hose **10** (commonly referred to as "tape") is made from an elongated strip of plastic film **14**, which is typically 4 to 15 mil thick. The film **14** can be made of any suitable material, for example, a laminate of high density polyethylene or polypropylene. Film **14** is folded longitudinally to form overlapping inner and outer longitudinal margins **16** and **18**, thus creating a seam. A first longitudinal rib **20** partially seals margins **16** and **18**. A second longitudinal rib **22**, outboard of rib **20**, completely seals margins **16** and **18**. Ribs **20** and **22** contain a repeating longitudinal pattern that defines a series of small flow regulating channels **24** along the length of the hose **10**. By virtue of the longitudinal fold in film **14**, the interior surface of film **14** defines a relatively large water supply passage **26**. The water supply passage **26** is connected to a source of water under pressure, not shown. Examples of such constructions are described in U.S. Patent Nos. 4,247,051, 4,984,739, 5,282,578, and 5,522,551, the disclosures of which are incorporated herein by reference.

As shown in FIG. 2, the flow regulating channels **24** (i.e., emitter regions) each have an inlet section **28**, a turbulent flow section **30**, and an outlet section **32**. For each flow regulating channel **24**, the inlet section **28** comprises one or more inlet openings to allow water to flow from the water supply passage **26** into the flow regulating channel **24**. In the depicted embodiment,

the inlet section **28** comprises a plurality of pillars **36** between which are formed openings **38**. As would be recognized by one skilled in the art, the inlet section **28** can have any other design that permits water to enter the flow regulating channel **24** from the water supply passage **26**.

The flow regulating channels **24** each have a much smaller cross-sectional area than the water supply passage **26**. The cross-sectional area of the water supply passage **26** is preferably from about 20 to 300 times, more preferably from about 50 to 200 times, larger than the cross-sectional area of the flow regulating channel **24**. Accordingly, each flow regulating channel **24** creates a passage between the water supply passage **26** and the outside of the hose **10** that controls the flow rate of the water flowing through it.

The flow regulating channels **24** can have any other design as is known in the art. For example, the turbulent flow section **30** can be formed of a series of chevrons, by a series of walls that form a serpentine path, or by any other configuration that creates turbulent flow. However, the turbulent flow section can be omitted if desired and replaced with a straight-path channel.

FIGs. 3 and 4 depict a method for making the drip irrigation hose shown in FIG. 1. As represented by a block **70**, the outlets **44** are first formed in film **14**. Preferably each outlet **44** comprises a single longitudinal slit in the film **14**, but could also be any other type of slit. A preferred method and apparatus for forming a knife-formed longitudinal slit outlet is described in U.S. Patent No. 5,522,551, the disclosure of which is incorporated herein by reference. Any other suitable method known in the art for providing outlets can also be used. For example, the surface of one of the outer margins **18** can be deformed to form protrusions in the film surface, and thereafter the protrusions are sliced from the film to form outlets, as described in U.S. Patent No. 5,123,984, the disclosure of which is incorporated herein by reference. Alternatively, the outlet section can comprises a plurality of pillars between which are formed outlet openings, in a manner similar to the inlet section described above.

As represented by block **72**, the inner margin **16** is then folded. As represented by block **74**, one or more beads are laid on the outside surface of the inner margin **14** by one or more extrusion nozzles. As represented by block **76**, a pattern is formed in ribs **20** and **22** by a molding wheel. As represented by block **78**, outer margin **18** is then folded onto inner margin **16**, with the formed ribs therebetween. Finally, as represented by block **80**, flow regulating passage **24** is finished by passing inner margin **16**, outer margin **18**, and the ribs **20** and **22** through the nip of a form wheel and a backing wheel to set precisely the height of the ribs.

FIG. 4 illustrates an assembly station for performing the above-described steps. One or more extrusion nozzles **82** deposit one or more continuous longitudinal beads **84** (in the form of hot molten glue or resin) on the outside surface of the inner margin **16**. The film **14** is passed through the nip of a rotating molding wheel **86** and a rotating backing wheel **88**. The molding wheel **86** contains a pattern of depressions **90** corresponding to the desired raised rib pattern, i.e., a pattern such as that shown in FIG. 2. In the nip, beads **84** are shaped by molding wheel **86** to form the desired bead pattern on film **14** for the entire length of the hose **10**. After leaving the

nip of wheels **86** and **88**, the external margin **18** of the film **14** is folded by a guide **92** to overlap the inner margin **16**. Finally, the overlapped margins of the film **14** pass through the nip of a form wheel **94** and a second backing wheel **96**. The form wheel **94** has a groove **98** that depresses the ribs formed by the beads **84** to set the rib height at a specified value that determines the flow rate of the hose **10**. During the described process, the film **14** is continuously transported by a conventional means, not shown. For example, the disclosed wheels could be driven, or other drive wheels could be provided, to transport the film.

Also, as would be recognized by one skilled in the art, the flow regulating channels **24** need not be formed in the margins **16** and **18** of the hose **10**, but can be provided at any location on the hose. For example, it is known in the art to provide discrete flexible emitters (not shown) that are adhered or otherwise bonded to the interior or exterior of the hose, with each emitter having an inlet in communication with the water supply passage and an outlet to the exterior of the hose, as described above. The emitters can be attached to the inside or outside of the hose by any of several methods including, but not limited to, adhesive bonding, solvent bonding, thermal bonding, and ultrasonic welding. For example, flexible discrete external emitters can be attached to the exterior of the hose, as described in U.S. Patent Application No. 09/136,354, entitled "External Emitter for Drip Irrigation Hose", the disclosure of which is incorporated by reference.

Alternatively, a continuous emitter can be bonded to the hose, where the continuous emitter has a serious of flow regulating channels along its length, inlets in communication with the water supply passage and outlets to the exterior of the hose, as described above. The continuous emitter can be manufactured into the irrigation hose by bonding it to the hose in any suitable manner known in the art, such as those described above. For example, the emitter can be extruded and formed by means of an embossing or imprinting tool. This technique is particularly useful if the hose is also being extruded. Thus, a continuous emitter could be extruded and formed, then inserted into a die center around which a hose is extruded. As the emitter and hose are extruded together, the emitter would be formed and adhered to the hose before it is cooled. Alternatively, the continuous emitter could be extruded and formed offline, and then fed through a hole in the die through which a hose is extruded. In another embodiment, the continuous emitter could be fed and joined to a long continuous strip that is then folded to form a hose.

In another embodiment, the drip irrigation hose is a hard hose having a plurality of discrete emitters (i.e., flow regulating channels) provided therein, as is known in the art and described, for example, in U.S. Patent Nos. 5,111,996 and 4,824,025.

A root deterrent strip **40** is attached to the interior or exterior of the hose **10** at or near the outlet(s) **32** to discourage root intrusion. The root deterrent strip **40** can be attached to the hose by any suitable means, such as bonding or, wrapping the fabric around the hose. FIG. 5A shows a root deterrent strip **40** attached longitudinally to the exterior of the hose **10** over the outlets **32**.

FIG. 5B shows a root deterrent strip **40** wrapped around the exterior of the hose **10** over the outlets **32**. FIG. 5C shows a root deterrent strip **40** attached longitudinally to the interior of the hose **10** over the outlets **32**. FIG. 5D shows a root deterrent strip **40** wrapped around the interior of the hose **10** over the outlets. FIG. 5E shows a root deterrent strip **40** attached longitudinally to the exterior of the hose **10** near, but not covering, the outlets **32**. FIG. 5F shows wrapped around the exterior of the hose **10** near, but not covering, the outlets **32**. As would be recognized by one skilled in the art, the root deterrent strip **40** could also be attached longitudinally to the interior of the hose **10** or wrapped around the interior of the hose near, but not covering, the outlets **32**. An advantage of using an externally attached root deterrent strip **40** is that the strip acts as a wick to more uniformly distribute the water along the path of the hose. Alternatively, the root deterrent strip **40** can be positioned partially to cover the inlets to the flow regulating channel **24**.

The root deterrent strip **40** comprises a fabric strip impregnated with a chemical herbicide. The fabric is sufficiently porous to allow water to flow through it so that it may cover the interior or exterior of the outlet opening(s) and sufficiently absorbent to hold the herbicide. Suitable fabrics for use in connection with the present invention include, but are not limited to, felt, plastic, and nonwovens (natural and synthetic), preferably needle-punched nonwovens. Any suitable chemical herbicide, i.e., root intrusion deterrent composition, can be employed. Preferred compositions include dinitroanilines, such as TREFLAN™ (trifluralin, 4-trifluoromethyl-2,6-dinitro-N,N-dipropyl aniline), SONALAN™ (ethalfluralin), PROWL™ (pendimethalin), and oryzalin (4-sulfonamido-2,6-dinitro-N,N-dipropyl aniline), dinoseb (2,4-dinitro-6-sec-butyl phenol), bromoxynil (3,5-dibromo-4-hydroxybenzonitrile), paraquat (1,1'-dimethyl-4,4'-bipyridinium dichloride), bromoxynil octanoic acid ester (3,5-dibromo-4-hydroxybenzonitrile octanoic acid ester), TBA (2,3,6,-trichlorobenzoic acid), 2,4-D (2,4-dichlorophenoxy acetic acid), and copper hydroxide. In a particularly preferred embodiment, the root deterrent strip **40** is made of Tex-R™ Agroliner (commercially available from Texel, Henderson, North Carolina).

The above-described embodiments of the invention are only considered to be preferred and illustrative of the inventive concepts. The scope of the invention is not to be restricted to such embodiments. For example, as would be recognized by one skilled in the art, the invention is not limited to hoses having flow regulating channels, as described above, but can be used with any hose having a water supply passage and outlets along the length of the hose. Various and numerous other arrangements may be devised by one skilled in the art without departing from the spirit and scope of the invention.